TECHNOLOGY DEPLOYMENTS FOR D&D APPLICATIONS

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Introduction

AEA Technology (AEAT) has collaborated with the US Department of Energy (US DOE), Office of Science and Technology for the past six years to transfer technologies and practices from the United Kingdom to the US DOE clean-up effort, through a series of projects. This partnership has resulted in several successful studies, demonstrations and deployments of innovative technologies and/or practices that offer benefits including schedule reduction, increased worker safety and/or cost savings. Projects have included personnel placements within DOE offices, participation on Integrated Contractor Teams (ICTs), demonstrations of innovative technologies or practices, creation of Options Studies for specific facilities or sites, and deployment of specialist equipment to meet challenging requirements across the complex. This paper summarizes projects completed during fiscal year 2001 for the Deactivation and Decommissioning Focus Area under the Industry Program of the Office of Science and Technology.

Objective

In collaboration with site representatives, AEAT works closely with the Focus Areas to identify problems around the complex that could benefit from demonstration or deployment of innovative technologies and/or practices. In addition, AEAT and representatives from Headquarters identify mutual areas of interest where the transfer of knowledge from the UK would be beneficial to US programs; for example, Long Term Stewardship, Project Risk Management, and D&D Planning Practices. AEA Technology has successfully completed or are near completion of a variety of projects in FY01, including:

1. Deployment of a hydraulic manipulator to the Columbus Environmental Management Project
2. Deployment of a hydraulic manipulator to the Bldg 324 facility at Hanford
3. Deployment of a Small Tank Mixing and Retrieval system to the WD Complex at Mound
4. Design review of available systems to gain access to the Retention Basin at INEEL

Approach

Columbus Environmental Management Project

The US DOE is responsible for decontaminating private facilities that became contaminated during research and development activities for the Federal Government. Battelle Memorial Institute (BMI) performed research and development activities for the Department of Energy and its predecessor agencies from 1943 to 1986 at the Battelle Columbus Laboratories sites in and around Columbus, Ohio. The nuclear research included fabrication of uranium and fuel elements, reactor development, submarine propulsion, fuel reprocessing, and safety studies of reactor vessels and piping as part of

the government's fuel and target fabrication program. The US DOE are working with Battelle to return the facilities and grounds to BMI in a safe and cost effective manner.

One of the major challenges in restoring the facility is the deactivation and decommissioning of the hot cells facility, JN-1, at the West Jefferson site. The hot cells have very high radiation levels and contain an estimated 6,000 curies of activity in the form of metallurgical samples, contaminated equipment, sediment and fuel pieces from the storage/transfer pool, and distributed contamination on interior cell surfaces. Radiation levels within the cells are in the tens of hundreds of R/hr range.

In an effort to minimize worker exposure, maximize schedule efficiency, and reduce overall project costs, the Office of Science and Technology (through the DDFA) have partnered with Battelle to procure and deploy a remote operated, heavy duty manipulator to size reduce, retrieve, and package the waste in the high and low level hot cells in Building JN-1. The manipulator's extended reach and heavy payload capability will assist the facility operators remove and package all of the debris from the hot cells without deploying workers directly in the cells.

Through a contract with the Office of Science and Technology, AEAT supplied a hydraulic manipulator, the ARTISAN ^{TM}, mounted on a self-propelled platform to Columbus. The system will be operated from a remote station outside of the contaminated area, minimizing worker exposure. The program of work included the supply of the manipulator and all necessary support and control equipment, as well as training/maintenance/operating procedures, and operator training.

The remote handling system will be operated by site operators, trained by AEA Technology, for a period of approximately two years to size reduce and package the wastes in the high and low level hot cells. The system may then be used to deploy decontamination tooling in the cells. The site are considering possible other deployments of the system; including, other hot cells within the facility, the pits, and/or the fuel storage/transfer pool.

Figure 1: ARTISAN ™ Manipulator

The project was initiated on December 1, 2000. Within seven months, AEA Technology designed, fabricated, tested, and demonstrated the system before it was delivered to site in June 2001. The supply of the manipulator will assist the site meet a critical path item on their closure schedule.

Hanford

The Department of Energy has accelerated the Decommissioning and Dismantlement Schedule of the facilities in the 300 Area at the Hanford Reservation site in Richland, Washington. As part of the overall decommissioning strategy at the site, it is planned to deactivate Building 324. The 324 Building is a hot cell facility that poses challenging problems to the Department including, highly contaminated hot cells, ductwork and storage tanks. The hot cells and supporting facilities were historically used for chemical and mechanical processing of specimens, ranging from natural background to mega-Curie activity levels.

Baseline deactivation activities in Building 324 require the use of mechanical master-slave manipulators (MSM). The MSMs have a limited load capacity of 25 lbs. The increased physical demands of the deactivation tasks have exceeded the intended design capacity of the MSMs. This has resulted in a significant increase in mechanical failures, with MSMs failing as often as once a week. The failures result in lost operational time and increased cost, as it takes significant manpower and hours to repair the existing MSMs.

Through a contract with the Office of Science and Technology, AEA Technology was assigned the task of deploying a remote operated, heavy duty manipulator to size reduce, retrieve, and package the waste in the Shielded Materials Facility (SMF) hot cell structure in Building 324. The system design was required to accomplish the following tasks:

- Size reduce debris located within the SMF cells;
- Obtain video through a camera mounted on the manipulator;
- Obtain radiological characterization data;
- Locate and retrieve highly active pins;
- Assist in the repair of the overhead crane;
- Inspect the PAR (existing) manipulator;
- Package waste in approved containers;
- Cell liner removal.

AEA Technology designed, fabricated and tested a system capable of accomplishing the tasks listed above and meeting the following specifications:

- 6 degrees-of-freedom manipulator with a gripping end effector;
- Deployable through existing 10” manipulator ports;
- Supply of master controller;
- Supply of hydraulic power unit for manipulator;
- Necessary cabling;
- Capability to operate within a maximum dose rate of 2×10^4 RAD/hr to a cumulative dose of 1×10^8 RAD;
- Acceptance testing at vendor’s site, followed by additional testing at Hanford;
- Training for operations and maintenance personnel at the 324 Facility;
- Operations, Training, and Maintenance Manuals;
- Recommended spare parts list.

Following the deployment of the ARTISAN ^{TM} manipulator to CEMP, AEA Technology enhanced the design of the system for Hanford. Several improvements were made including, the remote joystick unit, wiring, first rotational joint, and hydraulic power unit. A touch screen was added to the remote joystick unit and the hydraulic power pack, as well as additional soundproofing. The original 180° joint was replaced with a 360° joint to allow operators to reach the ceilings of the hot cells.

The ARTISAN ^{TM} system will be delivered to site, with a United Laboratories stamp, for a budget of $470,000. The project was initiated on February 15, 2001. The system is expected to be delivered to site by the end of November 2001. The system will be

deployed through a standard 10” manipulator port and operated by 324 Facility operators, after being trained by AEA Technology. The system is expected to operate in the SMF cells for approximately 24 months, or until the job is complete, before being transferred to another facility at Hanford for continued operations.

Figure 2: ARTISAN TM Manipulator Mock-up Facility

Figure 3: ARTISAN TM Remote Joystick Unit

Mound

The Mound site in Miamisburg, Ohio has been identified as a Closure site by the Department of Energy. One of the challenges the site is facing as they deactivate and decommission the facilities is the waste retrieval and eventual treatment of waste from the 36 waste tanks and sumps in the WD Complex. Building WD was the treatment facility for low specific activity (LSA) radioactive wastes generated by process activities at the site. This building was designed and constructed in 1948. Active and inactive processes housed in Building WD include alpha wastewater treatment, beta wastewater treatment, laboratory and bench-scale research, LSA waste drum repackaging, a glass melter furnace, and a packed bed reactor.

As the first step in the D&D of the facility, the 26 waste tanks and sumps containing waste must be emptied. The contents of the tanks and sumps will be retrieved and stored until a treatment process is identified. The walls of the tanks will then be washed and the cleaning solution will be retrieved and transported to a treatment process. Finally, the site will remove the tanks as part of the Facility Decommissioning project.

Through a contract with the Office of Science and Technology, AEA Technology was assigned the task of deploying a mobile, skid-mounted tank waste retrieval system to Mound to retrieve the waste from two storage tanks (WD Sludge Tanks). The system, a Small Tank Mixer (STM), was previously deployed at Oak Ridge as part of an Accelerated Site Technology Deployment (ASTD) Project.

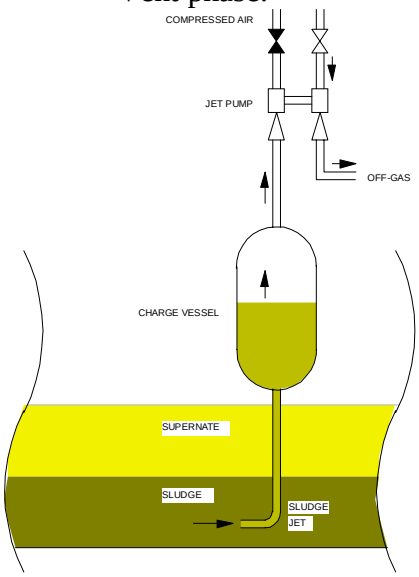
Figure 4: Small Tank Mixer at Oak Ridge

The system was modified to include the capability to wash the inside of the tanks after the waste was retrieved. New nozzles were designed to rotate 360° and travel up and down, vertically in the tank. The added capability provided the site a single system to retrieve the waste and clean the inside of the tanks.

The system is based on AEA Technology's pulsed jet mixing systems:

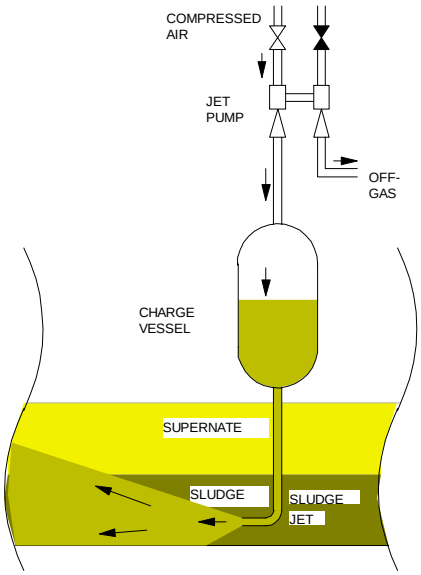
The pulsed jet agitation process is designed to mix sludge with liquid supernate or added water to enable transfer of the slurry out of the sludge tank. The system mixes tank material via a three phase mixing process:

- Suction phase;
- Drive phase; and
- Vent phase.



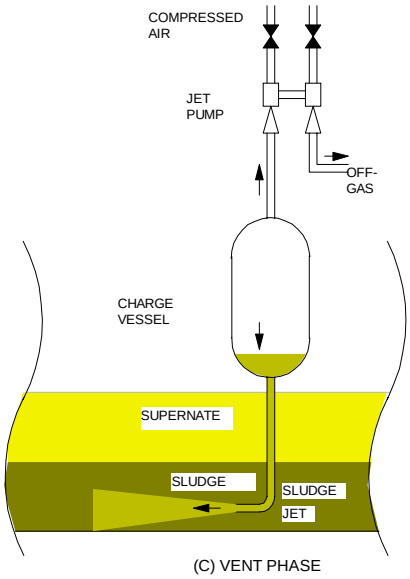
(A) SUCTION PHASE

During the suction phase, the jet pumps are used to create a partial vacuum in the charge vessel which in turn draws liquid up from the sludge tank into the charge vessel.



(B) DRIVE PHASE

Once the charge vessel is filled with the liquor, the jet pumps pressurize the charge vessel, which drives the liquor back into the sludge tank, agitating the contents of the tank and re-suspending settled solid particulates. This is referred to as the drive phase.



(C) VENT PHASE

When the liquor levels have reached the bottom of the charge vessel, the drive phase is terminated and the charge vessel is depressurized through the jet pumps in the vent phase.

Using this process, the tank material is repeatedly forced backwards and forwards between the tank and the charge vessel, thereby gradually entraining more sludge into the liquid. During this operation gas is vented out of the jet pumps to an off-gas system. The process is repeated until the sludge/liquid mixture around the tank nozzle breaks through into the overlaying aqueous or supernate layer. Once this occurs, the mixing cycle continues until the required suspended solids composition is reached, at which point the mobilized sludge/liquid is pumped out of the tank. Tank pump-out is achieved by filling the charge vessel from the sludge tank and then discharging the charge vessel to the delivery line instead of back to the sludge vessel.

The Small Tank Mixing System is comprised of two separate modules, namely the Control Hut and the Charge Vessel Skid. These modules have been designed to be easily transported between the various tanks to be mixed.

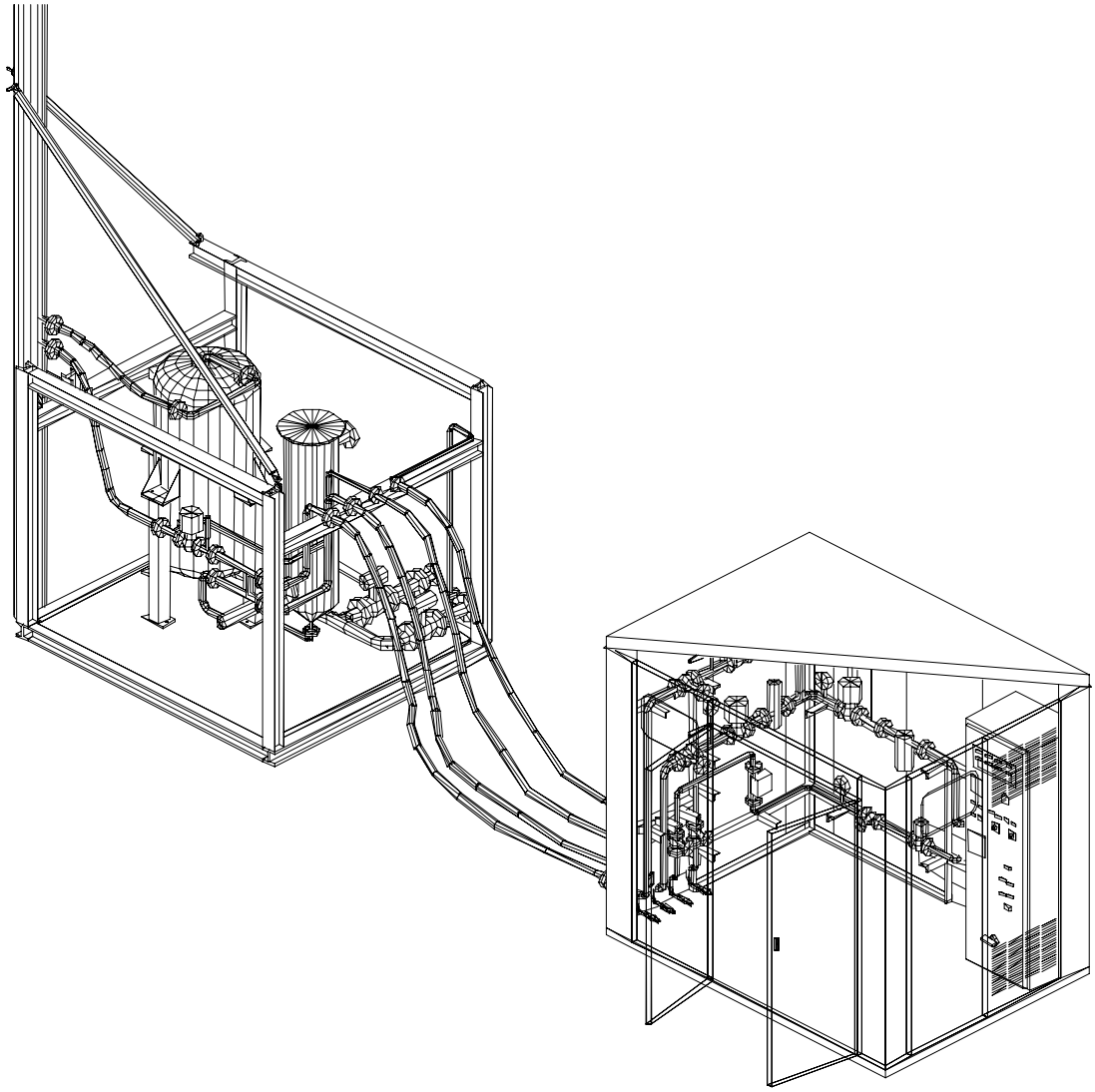


Figure 5: Small Tank Mixer Schematic

The Control Hut contains a valve skid and the system control panel. Mounted on the valve skid are the main process valves for controlling the operation of the Jet pumps (which are mounted on the Charge Vessel skid.) and the Wash Water line. The Control panel contains the Prescon controller and associated controls for Trace Heating and Jet Pump Heating.

The Charge vessel skid contains the principle plant items, namely the Charge Vessel, Demister, Jet Pump Pair, Barometric Protection Piping and main process valves.

The two modules are connected together by 4 flexible hoses, the connections for which have been arranged such that they drain towards the Control Hut. Two further hoses are employed; one to connect the Charge vessel to the sludge tanks in the WD Complex (via valve V/16) and the other to connect the Charge Vessel to the receiving vessel for the treatment unit (via valve V/15).

In addition to the above items, a portable compressor is required to provide compressed air for the system. A water source is also required for supplying dilution water for bulk mixing, and washing out the Charge Vessel and process lines at the end of a campaign.

At the request of the site, the original scope of the project was expanded to include installation and operation activities by AEA Technology operators. This change accelerated the project schedule by eliminating the requirement to train and test site operators and satisfied a labor supply issue.

The project was initiated on January 19, 2001 with an assigned budget of $476,800. The STM system was transferred from Oak Ridge to Mound in June 2001. The system will be operated for two months to retrieve the waste from two tanks, starting in November 2001. The site intends to continue to use the STM on the remaining tanks and sumps after the conclusion of this project.

Future Activities

AEA Technology are working with the DDFA to identify specific scopes of work for FY02, including:

1. Closed-loop decontamination system for Savannah River;
2. Storage tank inspection and retrieval system for INEEL and LANL;
3. ARTISAN ^{TM} deployment support for CEMP and Hanford;
4. Remote handling system deployment;
5. Duct decontamination system demonstration for Hanford;
6. Solid debris retrieval system for RFETS;
7. Large diameter sphere decontamination for LANL;
8. On-call support to DDFA and LSDDPs.

The specific scope for FY02 will be identified when the budget has been finalized.

Contact Information

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